

# PATENT ABSTRACTS OF JAPAN

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(21)Application number : 2000-208754 (71)Applicant : SUNCALL CORP

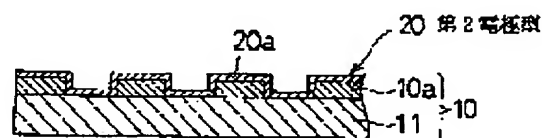
(22)Date of filing : 10.07.2000 (72)Inventor : MITSUO SADA AKI

## (54) MANUFACTURING METHOD OF ELECTRODE FOR FUEL CELL

### (57)Abstract:

PROBLEM TO BE SOLVED: To manufacture a quality electrode for fuel cell economically.

SOLUTION: A 1st electrode mold 10 (positive electrode mold) is manufactured by photo-forming, a 2nd electrode mold 20 (negative electrode mold) is manufactured by electric casting using the 1st electrode mold 10, a 3rd electrode mold (positive electrode mold) is manufactured by using the 2nd electrode mold 20, and the electrodes for fuel cells are economically manufactured by electric casting using the 3rd electrode mold.



## LEGAL STATUS

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**CLAIMS**

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[Claim(s)]

[Claim 1] In the approach of forming the electrode for fuel cells which comes to form the minute crevice of fine a large number in a metal thin sheet The 1st process which manufactures the conductive 1st electrode mold by photo forming, Next, the 2nd process which the mold front face of the 1st electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and manufactures the 2nd electrode mold of the shape of a sheet of the same structure as the electrode for fuel cells, Next, the 3rd process which manufactures the 3rd electrode mold of the shape of a sheet which the mold front face of the 2nd electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and has many minute crevices, Next, the manufacture approach of the electrode for fuel cells characterized by having the 4th process which the mold front face of the 3rd electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and manufactures sheet-like the electrode for fuel cells.

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**DETAILED DESCRIPTION**

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**[Detailed Description of the Invention]****[0001]**

**[Field of the Invention]** About the manufacture approach of the electrode for fuel cells, especially this invention manufactures the 1st electrode mold by photo forming, carries out sequential manufacture of the 2nd electrode mold and the 3rd electrode mold by electroforming after that, and relates to the approach of manufacturing the electrode for fuel cells of high quality using this 3rd electrode mold.

**[0002]**

**[Description of the Prior Art]** Conventionally, photo forming which combined the pattern formation technique of a photoresist and the technique of electroforming is forming the electrode of electroplating in the electrode mold, making this electrode mold electrodeposit a metal layer by electroplating, and exfoliating this metal layer, and is a technique which manufactures the various metal sheet objects of the thickness of several 10 - 100 micrometers of numbers. This photo forming is put in practical use more widely than before, and according to this photo forming, since an ADDA cut does not occur like photo etching, it can perform foaming, such as still finer sharp various crevices and irregularity of a configuration, and a detailed hole. For example, a cutting edge, a detailed screen, a detailed mesh, a detailed filter, etc. are manufactured with the technique of photo forming outside the various masks for chemical vacuum deposition, and an electric shaver from the former.

**[0003]** On the other hand, an automaker is developing the component engineering wholeheartedly towards utilization of an automotive fuel cell recently. For example, a potassium hydroxide solution is used for the electrolytic solution in the fuel cell which uses hydrogen and oxygen as a fuel, and it is O<sub>2</sub> as positive active material to the front face of this positive electrode. Gas is supplied and it is H<sub>2</sub> as a negative-electrode active material to the front face of a negative electrode. Gas is supplied, the current and the electrolytic solution which are generated between a positive electrode and a negative electrode are minded, and it is H<sub>2</sub>. Gas and O<sub>2</sub> Gas is made to react and it generates electricity. as this kind of an electrode for fuel cells, the thin metal plate of nickel applies, for example -- having -- the front face of an electrode -- setting -- H<sub>2</sub> O<sub>2</sub> etc. -- the electrochemical reaction of an active material, the electrolytic solution, and a solid state electrode arises. Then, in order to promote contact to an electrode and an active material, many minute crevices with a diameter of about 1mm are formed in an electrode in all directions in a detailed pitch (about 1-2mm).

**[0004]**

**[Problem(s) to be Solved by the Invention]** When forming much crevices and irregularity in thin metal plates, such as said electrode for fuel cells, it usually forms by press forming. However, the manufacturing cost of metal mold becomes very expensive, and manufacturing the metal mold which forms many minute crevices with a diameter of about 1mm does not have it, although it is possible. [ practical ] Then, it is possible to manufacture the electrode for fuel cells by photo forming. However, an electrode mold is manufactured by photo forming, it is hard to release from mold smoothly [ in case the angle of a minute crevice becomes Sharp too much it is easy to produce a minute weld flash-like projection, the comparatively big electrode for fuel cells is manufactured and an electrode is released from mold ] only by forming the electrode for fuel cells by electroforming

using an electrode mold, and there is a problem of being easy to produce defects, such as a minute crack. The purpose of this invention is offering the manufacture approach of the electrode for fuel cells which can solve the aforementioned technical problem.

[0005]

[Means for Solving the Problem] In the approach of forming the electrode for fuel cells with which the manufacture approach of the electrode for fuel cells of claim 1 comes to form the minute crevice of fine a large number in a metal thin sheet The 1st process which manufactures the conductive 1st electrode mold by photo forming, Next, the 2nd process which the mold front face of the 1st electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and manufactures the 2nd electrode mold of the shape of a sheet of the same structure as the electrode for fuel cells, Next, the 3rd process which manufactures the 3rd electrode mold of the shape of a sheet which the mold front face of the 2nd electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and has many minute crevices, Next, it is characterized by having the 4th process which the mold front face of the 3rd electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and manufactures sheet-like the electrode for fuel cells.

[0006] At the 1st process, the conductive 1st electrode mold is manufactured by photo forming. In this case, the base plate made from a nonmetal in which the electric conduction coat was formed on a metal base plate or a metal front face is used. To that base plate, by for example, the thing exposed where the masking negative which applied the photoresist of a positive type and formed the predetermined pattern in this photoresist is piled up Remove photoresists other than the photoresist of a predetermined pattern, and it has left the photoresist of the predetermined pattern. a base member is immersed in a predetermined electroplating bath (for example, sulfuric-acid nickel-plating bath), using the anode plate made from nickel, where a base plate is used as cathode, it electrocasts to a base plate, and a metal is electrodeposited -- making -- the -- if all photoresists are removed after carrying out a postexposure, the 1st electrode mold will be obtained.

[0007] Next, at the 2nd process, after applying a predetermined release agent (for example, red ocher) to the mold front face of the 1st electrode mold, it is immersed in said same electroplating bath, and using the anode plate made from nickel, where the 1st electrode mold is used as cathode The mold front face of the 1st electrode mold is made to electrodeposit a metal (for example, nickel) by electroforming, it exfoliates after that, and the 2nd electrode mold of the shape of a sheet of the same structure as the electrode for fuel cells is manufactured.

[0008] Next, where it formed the insulator layer in the mold front face of the 2nd electrode mold, and the field of the opposite side and said same predetermined release agent is applied to the mold front face of the 2nd electrode mold at the 3rd process The 3rd electrode mold of the shape of a sheet which the mold front face of the 2nd electrode mold is made to electrodeposit a metal (for example, nickel) by electroforming, exfoliates after that, and has many minute crevices in the condition that the 2nd electrode mold was immersed in said same electroplating bath is manufactured.

[0009] Next, where it formed the insulator layer in the mold front face of the 3rd electrode mold, and the field of the opposite side and said same predetermined release agent is applied to the mold front face of the 2nd electrode mold at the 4th process In the condition that the 3rd electrode mold was immersed in said same electroplating bath, the mold front face of the 3rd electrode mold is made to electrodeposit a metal (for example, nickel) by electroforming, it exfoliates after that, and sheet-like the electrode for fuel cells is manufactured.

[0010]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. First, the structure of the electrode for fuel cells of an automobile is explained. The electrode for fuel cells of an automobile (henceforth the electrode for cells) is applied to the positive electrode or negative electrode of a fuel cell, and, in the case of this operation gestalt, is a thing made from nickel.

[0011] As shown in drawing 1 - drawing 3 , the electrode 1 for cells is the thing of the shape of a sheet of the shape of a rectangle of for example, A4 seal size, thickness  $t$  is 200-300 micrometers, and many minute crevices 2 (outer diameter  $d = \text{mm}$  [ about 1.0 ], a depth of  $h = 0.4\text{-}0.8\text{mm}$ ) are formed in the direction in every direction in the shape of a matrix in the minute pitch  $a$  (for example,

a= 1.5-2.5mm). However, it may form so that the minute crevice 2 may not restrict being formed in the whole surface but may serve as a predetermined pattern.

[0012] Next, the manufacture approach of the aforementioned electrode for cells is explained.

The 1st process (manufacture of the electrode [ 1st ] mold): As shown in drawing 4 , create the positive original edition 4 which made the part corresponding to the minute crevice 2 the black dot 3, and made other parts transparence using a transparence glass plate. The diameter of the black dot 3 in this positive original edition 4 is equal to the outer diameter d of the minute crevice 2 in drawing 3 , and the pitch of a black dot 3 in every direction is equal to the pitch a of the minute crevice 2.

[0013] Next, as shown in drawing 5 - drawing 8 , the conductive 1st electrode mold 10 is manufactured by photo forming. In this case, as shown in drawing 5 , while first forming the photoresist layer 12 which consists of a positive type photoresist of the suitable thickness for the top face of the metal (for example, the product made from phosphor bronze or the product made from stainless steel) base plate 11 of A4 seal size, where the positive original edition 4 is laid on top of the top face of that photoresist layer 12, from the upper part, ultraviolet rays and excimer laser are irradiated and are exposed. Since photoresist layers 12 other than the part corresponding to said black dot 3 are destroyed by this exposure, if the fluoric acid solution of suitable concentration etc. washes, the pattern which is equivalent to the positive original edition 4 as shown in drawing 6 can be developed.

[0014] Next, nickel plating as electroforming is performed until the base plate 11 with the same photoresist pattern as said positive original edition 4 is immersed in a nickel-plating organ bath and it becomes a photoresist layer 12 and the same thickness, as shown in drawing 7 . In this case, the liquid which uses for example, a nickel-sulfate solution as a principal component as plating liquid of a nickel-plating organ bath is applied, the base plate 11 is used as cathode, and plating processing (electroforming) is performed using the anode plate made from nickel. By this plating processing, the nickel of an anode plate will be electrodeposited to the pace plate 11 of cathode.

[0015] Then, if photoresist layer 12a corresponding to the matrix-like black dot 3 is destroyed and it washes by the penetrant remover suitable after that by picking out the base plate 11 from a nickel-plating organ bath, and irradiating ultraviolet rays and excimer laser after desiccation on the top face of the base plate 11, the 1st electrode mold 10 as shown in drawing 8 will be obtained. This 1st electrode mold 10 should also be called positive electrode mold.

[0016] The 2nd process (manufacture of the electrode [ 2nd ] mold): At this 2nd process, it is the 2nd electrode mold 20 of the shape of a sheet which the mold front face of the aforementioned 1st electrode mold 10 is made to electrodeposit nickel, exfoliates after that, and has many minute crevices, and manufacture the electrode mold 1 for fuel cells, and the 2nd electrode mold 20 of the same structure.

[0017] In this case, the first suitable release agent for the mold front face of the 1st electrode mold 10 After applying (for example, red ocher) in the shape of a thin film, the 1st electrode mold 10 is immersed in the same nickel-plating organ bath as the above. Using the anode plate of the above, the same plating liquid, and the product made from nickel, only time amount sufficient as cathode carries out plating processing (electroforming) of the 1st electrode mold 10, and electrodeposited layer 20a of nickel with a thickness of about 200-300 micrometers is formed in the mold front face of the 1st electrode mold 10.

[0018] Then, if the 1st electrode mold 10 is picked out from a nickel-plating organ bath and electrodeposited layer 20a is exfoliated, the 2nd electrode mold 20 of the shape of a sheet with many minute crevices of the same structure as the electrode 1 for fuel cells will be obtained. In addition, this 2nd electrode mold 20 is equivalent to a negative electrode mold, and as shown in drawing 10 on the relation in which inferior-surface-of-tongue [ this 2nd electrode type 20 of ] side serves as a mold front face, it forms in the mold front face of the 2nd electrode mold 20, and the top face of the opposite side the insulator layer 21 which consists of a synthetic-resin ingredient.

[0019] The 3rd process (manufacture of the electrode [ 3rd ] mold): Manufacture the 3rd electrode mold of the shape of a sheet which the mold front face of the 2nd electrode mold 20 is made to electrodeposit nickel, exfoliates after that, and has many minute crevices at this 3rd process. In this case, first, after applying said same release agent to the mold front face by the side of the inferior surface of tongue of the 2nd electrode mold 20 As the 2nd electrode mold 20 is immersed in the

same nickel-plating organ bath as the above, only time amount sufficient as cathode carries out plating processing (electrocasting processing) and the 2nd electrode mold 20 is shown in drawing 11 using the anode plate of the above, the same plating liquid, and the product made from nickel Electrodeposited layer 30a of nickel with a thickness of about 300-400 micrometers is formed in the mold front face of the 2nd electrode mold 20.

[0020] Then, if the 2nd electrode mold 20 is picked out from a nickel-plating organ bath and electrodeposited layer 30a is exfoliated, the 3rd electrode mold 30 of the shape of a sheet with many minute crevices as shown in drawing 12  $R > 2$  will be obtained. In addition, this 3rd electrode mold 30 should also be called positive electrode mold, and as shown in drawing 12 on the relation in which top-face [ this 3rd electrode type 30 of ] side serves as a mold front face, it forms in the mold front face of the 3rd electrode mold 30, and the inferior surface of tongue of the opposite side the insulator layer 31 which consists of a synthetic-resin ingredient.

[0021] The 4th process (manufacture of the electrode for fuel cells): At this 4th process, make the mold front face of the 3rd electrode mold 30 electrodeposit nickel, exfoliate after that, and manufacture the sheet-like electrode 1 for fuel cells. In this case, first, after applying said same release agent to the mold front face of the 3rd electrode mold 30 As the 3rd electrode mold 30 is immersed in the same nickel-plating organ bath as the above, only time amount sufficient as cathode carries out plating processing (electrocasting processing) and the 3rd electrode mold 30 is shown in drawing 13 using the anode plate of the above, the same plating liquid, and the product made from nickel Electrodeposited layer 1a of nickel with a thickness of about 200-300 micrometers is formed in the mold front face of the 3rd electrode mold 30.

[0022] Then, if the 3rd electrode mold 30 is picked out from a nickel-plating organ bath and electrodeposited layer 1a is exfoliated, the electrode 1 for fuel cells of the shape of a sheet with many minute crevices as shown in drawing 14 will be obtained.

[0023] According to the manufacture approach of the electrode for cells explained above, the conductive 1st electrode mold 10 is manufactured by photo forming. Next, make nickel electrodeposit by electroforming using this 1st electrode mold 10, and the 2nd electrode mold 20 is manufactured. Next, since make nickel electrodeposit by electroforming using this 2nd electrode mold 20, and manufacture the 3rd electrode mold 30, then use this 3rd electrode mold 30, nickel is made to electrodeposit by electroforming and the electrode for fuel cells is manufactured Even if it is the comparatively big electrode 1 for fuel cells, without the angle of a minute crevice not becoming Sharp too much, and a minute weld flash-like projection arising In case the electrode 1 for fuel cells is released from mold, become easy to release from mold smoothly, it is hard coming to also generate defects, such as a minute crack, and the electrode for fuel cells of high quality can be mass-produced economically.

[0024] Next, the modification which changes said operation gestalt partially is explained. The base plate 1 does not necessarily need to be metal and the thing in which the electric conduction film was formed on the front face of the base plate made from a nonmetal is sufficient as it. Moreover, although said operation gestalt explained as an example the case where the electrode 1 for fuel cells made from nickel was manufactured, the electrode 1 for fuel cells may not be restricted to the product made from nickel, and the product made from aluminum, the product made from chromium, and a copper electrode are sufficient as it. In this case, what is necessary is just to electrocast in the 4th process using which anode plates, such as aluminum, chromium, and copper, using respectively suitable plating liquid. In addition, it cannot be overemphasized that it can carry out with the gestalt which added various modification to said operation gestalt, without deviating from the meaning of this invention.

[0025]

[Effect of the Invention] According to the manufacture approach of the electrode for fuel cells of claim 1, the conductive 1st electrode mold (equivalent to a positive electrode mold) is manufactured by photo forming. Next, make a metal electrodeposit by electroforming using this 1st electrode mold, and the 2nd electrode mold (equivalent to a negative electrode mold) is manufactured. Next, since make a metal electrodeposit by electroforming using this 2nd electrode mold, and manufacture the 3rd electrode mold (equivalent to a positive electrode mold), then use this 3rd electrode mold, a metal is made to electrodeposit by electroforming and the electrode for fuel cells was manufactured

Even if it is a comparatively big electrode for fuel cells, without the angle of a minute crevice not becoming Sharp too much, and a minute weld flash-like projection arising In case an electrode is released from mold, become easy to release from mold smoothly, it is hard coming to also generate defects, such as a minute crack, and the electrode for fuel cells of high quality can be mass-produced economically.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the top view of the electrode for fuel cells concerning the operation gestalt of this invention.

[Drawing 2] It is the important section enlarged drawing of the electrode for fuel cells.

[Drawing 3] It is the important section expanded sectional view of the electrode for fuel cells.

[Drawing 4] It is the important section expansion top view of the positive original edition.

[Drawing 5] It is the important section expanded sectional view of a base plate, a photoresist layer, and the positive original edition.

[Drawing 6] It is the important section expanded sectional view of a base plate and a photoresist layer.

[Drawing 7] It is the important section expanded sectional view of a base plate, a photoresist layer, and an electrodeposited layer.

[Drawing 8] It is the important section expanded sectional view of the 1st electrode mold.

[Drawing 9] It is the important section expanded sectional view of the 1st electrode mold and an electrodeposited layer.

[Drawing 10] It is the important section expanded sectional view of the 2nd electrode mold.

[Drawing 11] It is the important section expanded sectional view of the 2nd electrode mold and an electrodeposited layer.

[Drawing 12] It is the important section expanded sectional view of the 3rd electrode mold.

[Drawing 13] It is the important section expanded sectional view of the 3rd electrode mold and an electrodeposited layer.

[Drawing 14] It is the important section expanded sectional view of the electrode for fuel cells which exfoliated from the 3rd electrode mold.

[Description of Notations]

1 Electrode for Fuel Cells

2 Minute Crevice

10 1st Electrode Mold

20 2nd Electrode Mold

30 3rd Electrode Mold

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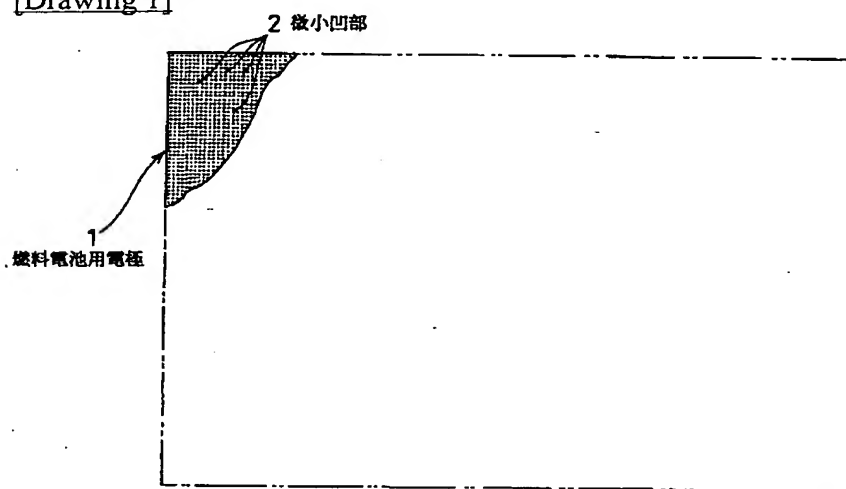
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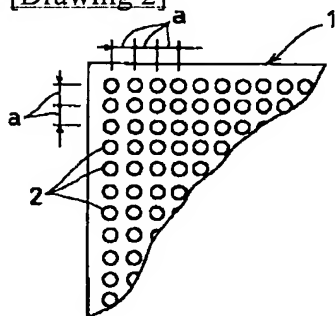
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## DRAWINGS

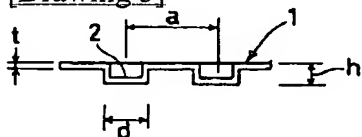
[Drawing 1]



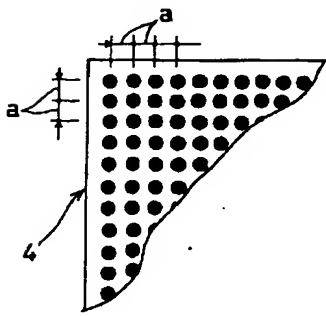
[Drawing 2]



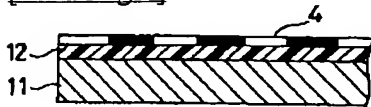
[Drawing 3]



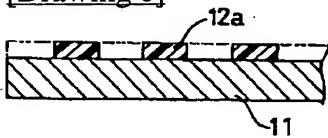
[Drawing 4]



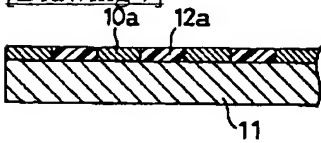
[Drawing 5]



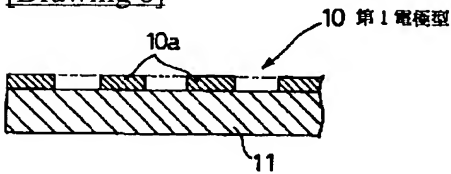
[Drawing 6]



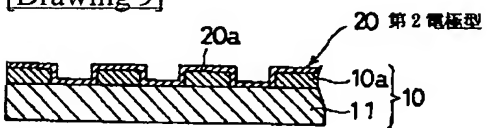
[Drawing 7]



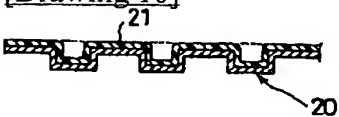
[Drawing 8]



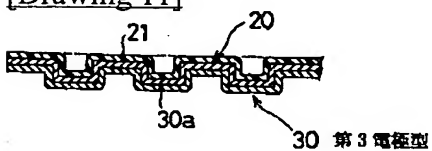
[Drawing 9]



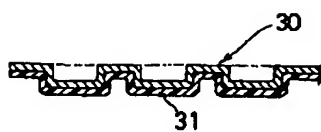
[Drawing 10]



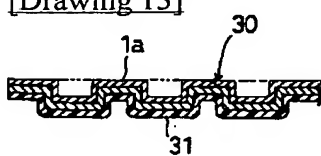
[Drawing 11]



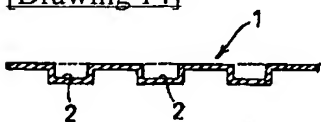
[Drawing 12]



[Drawing 13]



[Drawing 14]



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[Translation done.]

(10) 日本国特許庁 (J P)

## (12) 公開特許公報 (A)

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Pターム(参考) 5H018 AM03 B607 EE02

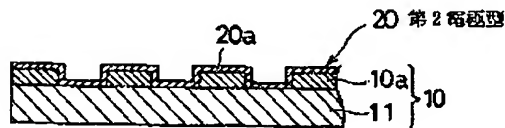
5H026 AM03 B600 B604 CC04 EE02

(54) 【発明の名称】 燃料電池用電極の製造方法

## (57) 【要約】

【課題】 燃料電池用電極をプレス成形で製作する場合は、金型が非常に高価になり現実的でなく、燃料電池用電極をフォトリソングの技術だけで製作すると、高品質のものを製作することが難しい。

【解決手段】 フォトリソングにより第1電極型10（ポジ電極型）を製作し、この第1電極型10を用いて電気鋳造することで第2電極型20（ネガ電極型）を製作し、この第2電極型20を用いて電気鋳造することで第3電極型（ポジ電極型）を製作し、その第3電極型を用いて電気鋳造することで高品質の燃料電池用電極を経済的に製作する。



(2)

特開2002-25573

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【特許請求の範囲】

【請求項1】 金属製の薄いシートに細かい多数の微小凹部を形成してなる燃料電池用電極を形成する方法において、

フォトリソグラフィにより導電性の第1電極型を製作する第1の工程と、

次に第1電極型の型表面に金属を電気蒸着で電着させその後剥離して燃料電池用電極と同様の構造のシート状の第2電極型を製作する第2の工程と、

次に第2電極型の型表面に金属を電気蒸着で電着させその後剥離して多数の微小凹部のあるシート状の第3電極型を製作する第3の工程と、

次に第3電極型の型表面に金属を電気蒸着で電着させその後剥離してシート状の燃料電池用電極を製作する第4の工程と、

を備えたことを特徴とする燃料電池用電極の製造方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は燃料電池用電極の製造方法に関し、特にフォトリソグラフィにより第1電極型を製作し、その後電気蒸着により第2電極型、第3電極型を順次製作し、この第3電極型を用いて高品質の燃料電池用電極を製造する方法に関する。

【0002】

【従来の技術】 従来、フォトリソグラフィのパターン形成技術と電気蒸着の技術とを組み合わせたフォトリソグラフィは、電気メッキの電極を電極型に形成しておき、この電極型に電気メッキにより金属層を電着させ、この金属層を剥離することで、数10～数100μmの厚さの種々の金属製シート体を製作する技術である。このフォトリソグラフィは従来より広く実用化されており、このフォトリソグラフィによれば、フォトリソグラフィのようにアッダーカットが発生しないため、一層細かいシャープな種々の形状の凹部や凹凸や微細な穴などのフォトリソグラフィを行うことができる。例えば、従来から、種々の化学蒸着用マスク、電気カミソリの外刃、微細スクリーン、微細メッシュ、微細フィルタなどは、フォトリソグラフィの技術で製作されている。

【0003】 一方、最近自動車メーカーは自動車用燃料電池の実用化に向けてその要素技術を鋭意開発中である。例えば、水素と酸素を燃料とする燃料電池では、電解液に水酸化カリウム溶液を用い、この正極の表面に正極活性物質としてのO<sub>2</sub>、ガスを供給し、負極の表面に負極活性物質としてのH<sub>2</sub>ガスを供給し、正極と負極間に発生する電流と電解液を介して、H<sub>2</sub>ガスとO<sub>2</sub>ガスを反応させて発電する。この種の燃料電池用電極としては、例えばニッケルの薄金属板が適用され、電極の表面においてH<sub>2</sub>やO<sub>2</sub>などの活性物質と電解液と固体電極との電気化学反応が生じる。そこで、電極と活性物質との接触を促進する為に、電極には直径約1mm程度の微小凹部が微

細ピッチ（約1～2mm）で縦横に多数形成される。

【0004】

【発明が解決しようとする課題】 前記燃料電池用電極など薄い金属板に多数の凹部や凹凸を形成する場合は、通常プレス成形により形成する。しかし、直径約1mm程度の微小の凹部を多数形成する金型を製作することは可能ではあるが、金型の製作費が非常に高価になり、実用的でない。そこで、フォトリソグラフィにより燃料電池用電極を製作することが考えられる。しかし、フォトリソグラフィにより電極型を製作し、電極型を用いて電気蒸着により燃料電池用電極を形成するだけでは、微小凹部の角がシャープになり過ぎ、バリ状の微小突起が生じやすく、比較的大きな燃料電池用電極を製作する際には電極を剥離する際に円滑に剥離しにくく、微小なクラックなどの欠陥が生じやすい、という問題がある。本発明の目的は、前記の課題を解決できるような燃料電池用電極の製造方法を提供することである。

【0005】

【課題を解決するための手段】 請求項1の燃料電池用電極の製造方法は、金属製の薄いシートに細かい多数の微小凹部を形成してなる燃料電池用電極を形成する方法において、フォトリソグラフィにより導電性の第1電極型を製作する第1の工程と、次に第1電極型の型表面に金属を電気蒸着で電着させその後剥離して燃料電池用電極と同様の構造のシート状の第2電極型を製作する第2の工程と、次に第2電極型の型表面に金属を電気蒸着で電着させその後剥離して多数の微小凹部のあるシート状の第3電極型を製作する第3の工程と、次に第3電極型の型表面に金属を電気蒸着で電着させその後剥離してシート状の燃料電池用電極を製作する第4の工程とを備えたことを特徴とするものである。

【0006】 第1工程では、フォトリソグラフィにより導電性の第1電極型を製作する。この場合、金属製のベース板又は表面に導電被膜を形成した非金属製のベース板を用い、そのベース板に例えばポジ型のフォトリソレジストを塗布し、このフォトリソレジストに所定のパターンを形成したマスクング原板を重ねた状態で露光することで、所定のパターンのフォトリソレジスト以外のフォトリソレジストを除去し、その所定のパターンのフォトリソレジストを残したまま、ベース部材を所定の電気メッキ浴（例えば、硫酸ニッケルメッキ浴）に浸漬し、ニッケル製の陽極を用い、ベース板を陰極とした状態でベース板に電気蒸着を施して金属を電着させ、その後露光してから全てのフォトリソレジストを除去すると、第1電極型が得られる。

【0007】 次に、第2の工程では、第1電極型の型表面に所定の剥離剤（例えば、ベンガラ）を塗布してからそれを前記同様の電気メッキ浴に浸漬し、ニッケル製の陽極を用い、第1電極型を陰極とした状態で、第1電極型の型表面に金属（例えば、ニッケル）を電気蒸着で電着させその後剥離して燃料電池用電極と同様の構造のシ

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ート状の第2電極型を製作する。

【0008】次に、第3の工程では、第2電極型の型表面と反対側の面には絶縁膜を形成し、第2電極型の型表面には前記同様の所定の離型剤を塗布した状態で、第2電極型を前記同様の電気メッキ浴に浸漬した状態で、第2電極型の型表面に金属（例えば、ニッケル）を電気鍍造で電着させその後剥離して多数の微小凹部のあるシート状の第3電極型を製作する。

【0009】次に、第4の工程では、第3電極型の型表面と反対側の面には絶縁膜を形成し、第2電極型の型表面には前記同様の所定の離型剤を塗布した状態で、第3電極型を前記同様の電気メッキ浴に浸漬した状態で、第3電極型の型表面に金属（例えば、ニッケル）を電気鍍造で電着させその後剥離してシート状の燃料電池用電極を製作する。

【0010】

【発明の実施の形態】 以下、本発明の実施の形態について図面を参照して説明する。最初に、自動車の燃料電池用電極の構造について説明する。自動車の燃料電池用電極（以下、電池用電極という）は、燃料電池の正極又は負極に適用されるもので、本実施形態の場合ニッケル製のものである。

【0011】図1～図3に示すように、電池用電極1は、例えばA4判サイズの矩形状のシート状のもので、厚さtは例えば200～300 $\mu$ mであり、多数の微小凹部2（外径dは約1.0mm、深さhは0.4～0.8mm）が縦横方向に微小ピッチa（例えば、a=1.5～2.5mm）でマトリックス状に形成されている。但し、微小凹部2が全面に形成されるとは限らず、所定のパターンとなるように形成する場合もある。

【0012】次に、前記の電池用電極の製造方法について説明する。

第1工程（第1電極型の製作）：図4に示すように、微小凹部2に対応する部分を黒丸3にし、その他の部分を透明にしたポジ原版4を透明ガラス板を用いて作成する。このポジ原版4における黒丸3の直径は、図3における微小凹部2の外径dに等しく、黒丸3の縦横のピッチは微小凹部2のピッチaに等しい。

【0013】次に、図5～図8に示すように、フォトリソニングにより導電性の第1電極型10を製作する。この場合、まず、図5に示すように、A4判サイズの金属板（例えばリン青銅製又はステンレス製）のベース板11の上面に適当な厚さのポジ型フォトリソストからなるフォトリソスト層12を形成するとともに、そのフォトリソスト層12の上面にポジ原版4を重ね合わせた状態で、上方から紫外線やエキシマレーザを照射して露光する。この露光により、前記黒丸3に対応する部分以外のフォトリソスト層12が破壊されるので、適当な濃度のフッ酸溶液等で洗浄すると、図6に示すようにポジ原版4に相当するパターンを現像することができる。

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【0014】次に、図7に示すように、前記ポジ原版4と同様のフォトリソストパターンのあるベース板11をニッケルメッキ浴槽に浸漬し、フォトリソスト層12と同厚になるまで電気鍍造としてのニッケルメッキを施す。この場合、ニッケルメッキ浴槽のメッキ液としては例えば硫酸ニッケル溶液を主成分とする液を適用し、ベース板11を陰極とし、ニッケル製の陽極を用いてメッキ処理（電気鍍造）を行う。このメッキ処理により、陽極のニッケルが陰極のベース板11に電着することになる。

【0015】その後、ベース板11をニッケルメッキ浴槽から取り出して乾燥後、ベース板11の上面に紫外線やエキシマレーザを照射することにより、マトリックス状の黒丸3に対応するフォトリソスト層12aを破壊し、その後適当な洗浄液で洗浄すると、図8に示すような第1電極型10が得られる。この第1電極型10はポジ電極型とも言うべきものである。

【0016】第2工程（第2電極型の製作）：この第2工程では、前記の第1電極型10の型表面にニッケルを電着させその後剥離して多数の微小凹部のあるシート状の第2電極型20であって、燃料電池用電極型1と同様の構造の第2電極型20を製作する。

【0017】この場合、まず、第1電極型10の型表面に適当な離型剤（例えば、ベンガラ）を薄膜状に塗布してから、第1電極型10を前記と同様のニッケルメッキ浴槽に浸漬し、前記と同様のメッキ液とニッケル製の陽極を用い、第1電極型10を陰極として十分な時間だけメッキ処理（電気鍍造）して第1電極型10の型表面に約200～300 $\mu$ mの厚さのニッケルの電着層20aを形成する。

【0018】その後、第1電極型10をニッケルメッキ浴槽から取り出して、電着層20aを剥離すると燃料電池用電極1と同様の構造の多数の微小凹部のあるシート状の第2電極型20が得られる。尚、この第2電極型20は、ネガ電極型に相当するものであり、この第2電極型20の下面側が型表面となる関係上、図10に示すように、第2電極型20の型表面と反対側の上面には合成樹脂材料からなる絶縁膜21を形成しておく。

【0019】第3工程（第3電極型の製作）：この第3工程では、第2電極型20の型表面にニッケルを電着させその後剥離して多数の微小凹部のあるシート状の第3電極型を製作する。この場合、まず、第2電極型20の下面側の型表面に前記同様の離型剤を塗布してから、第2電極型20を前記と同様のニッケルメッキ浴槽に浸漬し、前記と同様のメッキ液とニッケル製の陽極を用い、第2電極型20を陰極として十分な時間だけメッキ処理（電気鍍造）して、図11に示すように、第2電極型20の型表面に約300～400 $\mu$ mの厚さのニッケルの電着層30aを形成する。

【0020】その後、第2電極型20をニッケルメッキ

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浴槽から取り出して、電着層30aを剥離すると、図12に示すような多数の微小凹部のあるシート状の第3電極型30が得られる。尚、この第3電極型30は、ポジ電極型とも言うべきものであり、この第3電極型30の上面側が型表面となる関係上、図12に示すように、第3電極型30の型表面と反対側の下面には合成樹脂材料からなる絶縁膜31を形成しておく。

【0021】第4工程（燃料電池用電極の製作）：この第4工程では、第3電極型30の型表面にニッケルを電着させその後剥離してシート状の燃料電池用電極1を製作する。この場合、まず、第3電極型30の型表面に前記同様の離型剤を塗布してから、第3電極型30を前記と同様のニッケルメッキ浴槽に浸漬し、前記と同様のメッキ液とニッケル製の陽極を用い、第3電極型30を陰極として十分な時間だけメッキ処理（電着処理）して、図13に示すように、第3電極型30の型表面に約200～300μmの厚さのニッケルの電着層1aを形成する。

【0022】その後、第3電極型30をニッケルメッキ浴槽から取り出して、電着層1aを剥離すると、図14に示すような多数の微小凹部のあるシート状の燃料電池用電極1が得られる。

【0023】以上説明した電池用電極の製造方法によれば、フォトリソングにより導電性の第1電極型10を製作し、次にこの第1電極型10を用いて電気焼造によりニッケルを電着させて第2電極型20を製作し、次にこの第2電極型20を用いて電気焼造によりニッケルを電着させて第3電極型30を製作し、次にこの第3電極型30を用いて電気焼造によりニッケルを電着させて燃料電池用電極を製作するので、微小凹部の角がシャープになり過ぎることがなく、バリ状の微小突起が生じることもなく、比較的大きな燃料電池用電極1であっても、その燃料電池用電極1を離型する際に円滑に離型しやすくなり、微小なクラックなどの欠陥も生じにくくなり、高品質の燃料電池用電極を経済的に量産できるようになる。

【0024】次に、前記実施形態を部分的に変更する変形例について説明する。ベース板1は必ずしも金属製でなくともよく、非金属製のベース板の表面に導電膜を形成したものでもよい。また、前記実施形態では、ニッケル製の燃料電池用電極1を製造する場合を例として説明したが、燃料電池用電極1はニッケル製に限るものではなく、アルミニウム製やクロム製や銅製の電極でもよい。この場合、第4工程において、夫々適切なメッキ液を用い、アルミニウム、クロム、銅などの何れかの陽極を用いて電気焼造を行えばよい。その他、本発明の趣旨

を逸脱することなく、前記実施形態に種々の変更を付加した形態で実施可能であることは言うまでもない。

【0025】

【発明の効果】 請求項1の燃料電池用電極の製造方法によれば、フォトリソングにより導電性の第1電極型（ポジ電極型に相当）を製作し、次にこの第1電極型を用いて電気焼造により金属を電着させて第2電極型（ネガ電極型に相当）を製作し、次にこの第2電極型を用いて電気焼造により金属を電着させて第3電極型（ポジ電極型に相当）を製作し、次にこの第3電極型を用いて電気焼造により金属を電着させて燃料電池用電極を製作するようにしたので、微小凹部の角がシャープになり過ぎることがなく、バリ状の微小突起が生じることもなく、比較的大きな燃料電池用電極であっても、電極を離型する際に円滑に離型しやすくなり、微小なクラックなどの欠陥も生じにくくなり、高品質の燃料電池用電極を経済的に量産できるようになる。

【図面の簡単な説明】

【図1】本発明の実施形態に係る燃料電池用電極の平面図である。

【図2】燃料電池用電極の要部拡大図である。

【図3】燃料電池用電極の要部拡大断面図である。

【図4】ポジ原版の要部拡大平面図である。

【図5】ベース板とフォトリソ層とポジ原版の要部拡大断面図である。

【図6】ベース板とフォトリソ層の要部拡大断面図である。

【図7】ベース板とフォトリソ層と電着層の要部拡大断面図である。

【図8】第1電極型の要部拡大断面図である。

【図9】第1電極型と電着層の要部拡大断面図である。

【図10】第2電極型の要部拡大断面図である。

【図11】第2電極型と電着層の要部拡大断面図である。

【図12】第3電極型の要部拡大断面図である。

【図13】第3電極型と電着層の要部拡大断面図である。

【図14】第3電極型から剥離した燃料電池用電極の要部拡大断面図である。

【符号の説明】

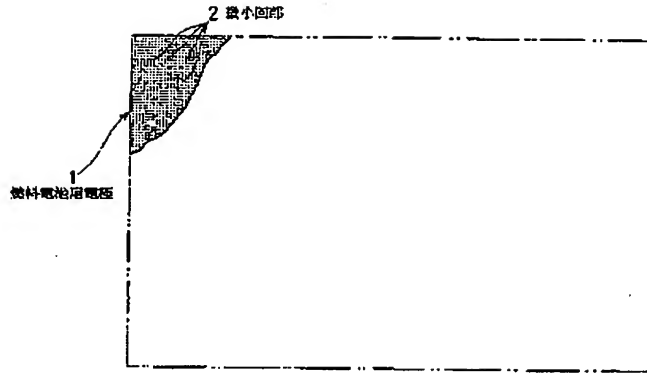
1	燃料電池用電極
2	微小凹部
10	第1電極型
20	第2電極型
30	第3電極型



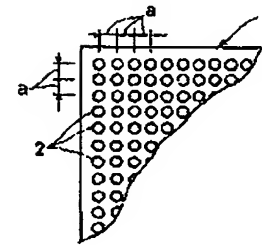
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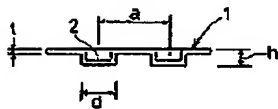
【図1】



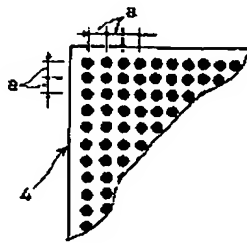
【図2】



【図3】



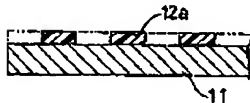
【図4】



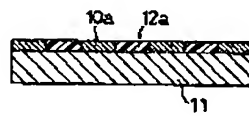
【図5】



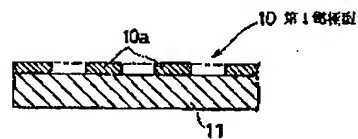
【図6】



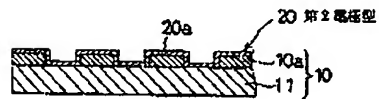
【図7】



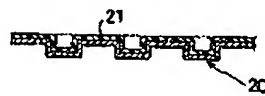
【図8】



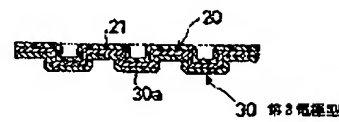
【図9】



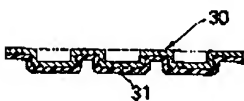
【図10】



【図11】



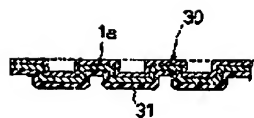
【図12】



(5)

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【図13】



【図14】



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## SEARCH REPORT

prepared on the basis of the latest  
claims filed before the search was started

National Registration No.:

FA 634647  
FR 0307961

DOCUMENTS CONSIDERED PERTINENT		Claims concerned of the examined application											
Category	Documents cited stating pertinent parts where necessary												
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A		9	Search Classes (Int. Cl. 7) H01M										
X	EP 1 160 900 A (RIKEN KK) 5 DECEMBER 2001 (2001-12-05) *PAGE 4, LINE 13 - PAGE 5, LINE 54; FIGURES 2-6* *PAGE 7, LINE 11-PAGE 8, LINE 51*	1											
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Y	*LINES 18-29*	2-6											
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Date of Search: 6 July 2004		Examiner: Thanos, I											
<p><b>CATEGORIES OF DOCUMENTS CITED</b></p> <table> <tr> <td>X: particularly pertinent by itself</td> <td>T: theory or principle at the basis of the invention</td> </tr> <tr> <td>Y: particularly pertinent in combination with another document in the same category</td> <td>E: patent document benefiting from a date prior to the filing date which was not published until this filing date or a subsequent date</td> </tr> <tr> <td>A: pertinent to at least one claim or general technological background</td> <td>D: cited in application</td> </tr> <tr> <td>O: unwritten disclosure</td> <td>L: cited for other reason</td> </tr> <tr> <td>P: intervening document</td> <td>&amp;: members of the same family, corresponding document</td> </tr> </table>				X: particularly pertinent by itself	T: theory or principle at the basis of the invention	Y: particularly pertinent in combination with another document in the same category	E: patent document benefiting from a date prior to the filing date which was not published until this filing date or a subsequent date	A: pertinent to at least one claim or general technological background	D: cited in application	O: unwritten disclosure	L: cited for other reason	P: intervening document	&: members of the same family, corresponding document
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DOCUMENTS CONSIDERED PERTINENT		Claims concerned of the examined application	Search Classes (Int. Cl. 7)										
Category	Documents cited stating pertinent parts where necessary												
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Date of Search: 6 JULY 2004		Examiner: Thanos, I											
<p><b>CATEGORIES OF DOCUMENTS CITED</b></p> <table border="0"> <tr> <td>X: particularly pertinent by itself</td> <td>T: theory or principle at the basis of the invention</td> </tr> <tr> <td>Y: particularly pertinent in combination with another document in the same category</td> <td>E: patent document benefiting from a date prior to the filing date which was not published until this filing date or a subsequent date</td> </tr> <tr> <td>A: pertinent to at least one claim or general technological background</td> <td>D: cited in application</td> </tr> <tr> <td>O: unwritten disclosure</td> <td>L: cited for other reason</td> </tr> <tr> <td>P: intervening document</td> <td>&amp;: members of the same family, corresponding document</td> </tr> </table>				X: particularly pertinent by itself	T: theory or principle at the basis of the invention	Y: particularly pertinent in combination with another document in the same category	E: patent document benefiting from a date prior to the filing date which was not published until this filing date or a subsequent date	A: pertinent to at least one claim or general technological background	D: cited in application	O: unwritten disclosure	L: cited for other reason	P: intervening document	&: members of the same family, corresponding document
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